LA-UR-19-28625
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Title: Revolver-19B Campaign Preview

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Intended for: Experiment overview presentation for upcoming experiment

Issued: 2019-08-26

Revolver-19B Campaign Preview

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August 26, 2019

Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA

Revolver is a close collaboration between LANL and LLE

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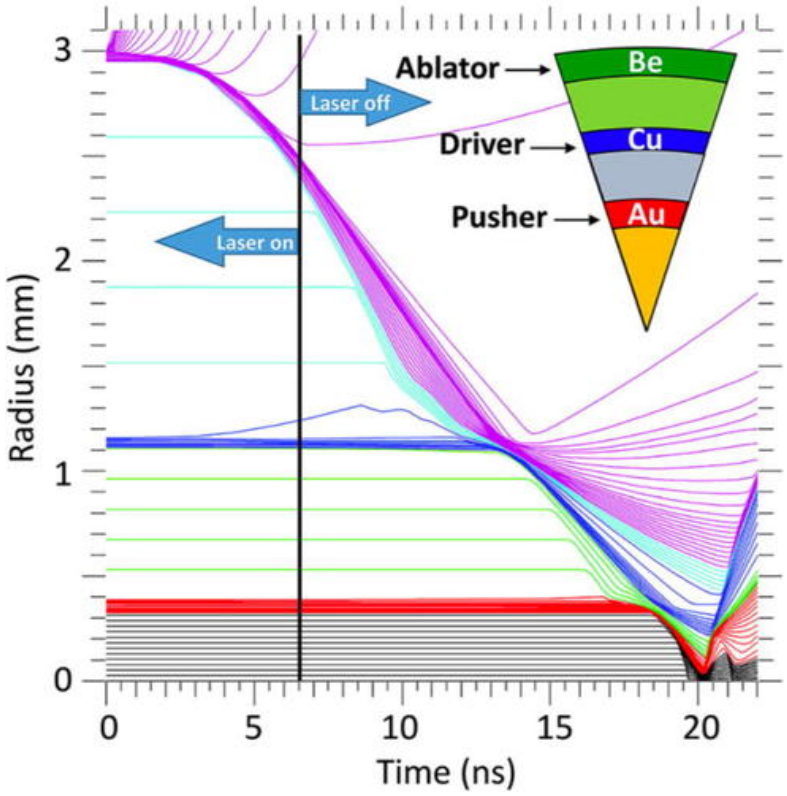
Riccardo Betti
Patrick McKenty
Danae Polsin
Frederic Marshall
Phil Nilson
Thomas Boehly
and others who support Omega shots!

What is Revolver?

- **Direct-drive, multi-shell ICF concept that aims to efficiently convert 6 ns of NIF's laser energy into a 1-ns dynamic pressure pulse to achieve volume-like ignition in liquid DT after spherical convergence of 9 by a high-*Z* pusher**

- **Project goals (FY18–FY20): validate crucial physics issues and produce credible design of Revolver to potentially impact national ICF program planning in the 2020 time frame**

- **Impacts for LANL/LLE include leading an innovative direct-drive ignition effort with clear HED applications**



K. Molvig et al., PRL **116**, 25503 (2016)

Revolver19A provided outer surface trajectory Revolver19B will develop diagnostics to bound shell velocity dispersion and measure shell mode perturbations

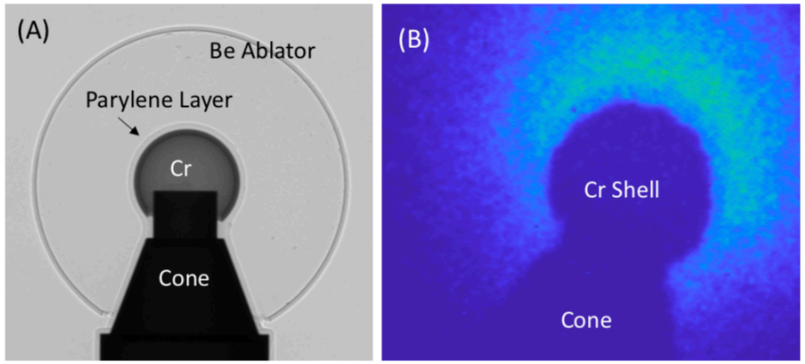


FIG. 2. (A) A pre-shot radiograph showing the Be ablator, Cr inner shell with parylene layer, and gold support cone. (B) A backlit image of the imploding Cr shell and cone.

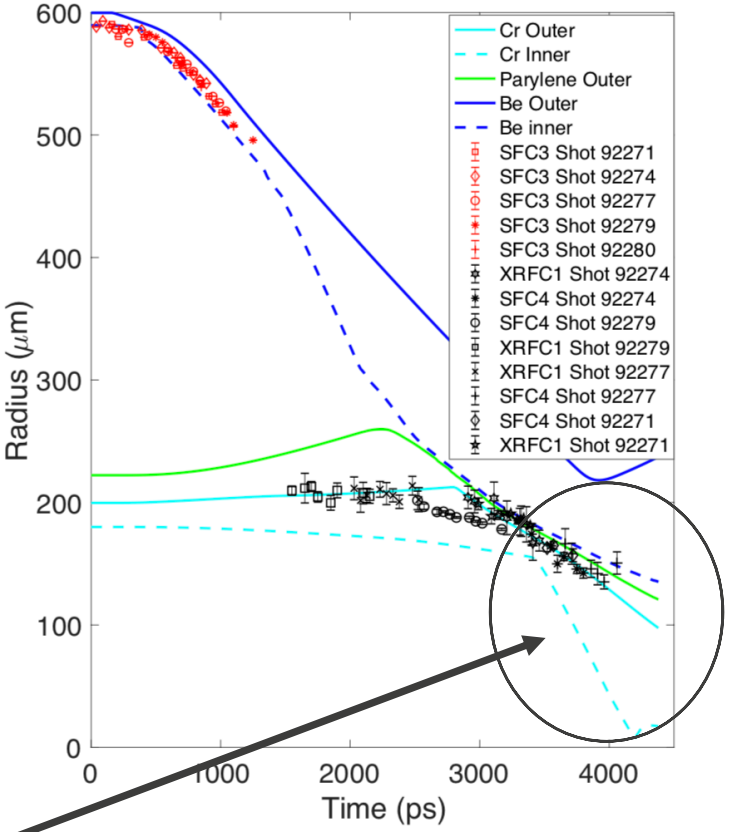


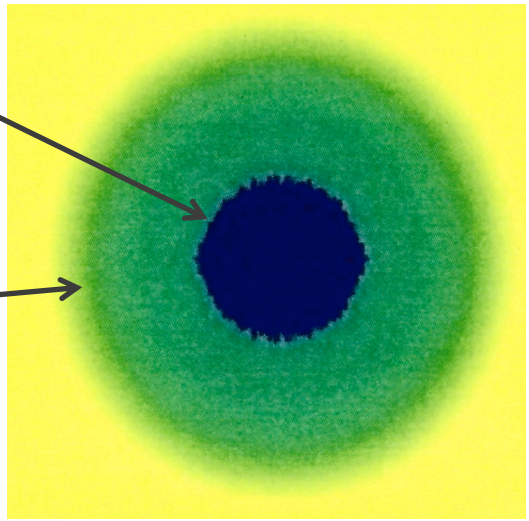
FIG. 4. A comparison of the measured ablator and driver shell radii with simulation data. The dotted (solid) lines represent the inner (outer) edges of the two shells and the parylene coating (green) on the outside of the inner shell.

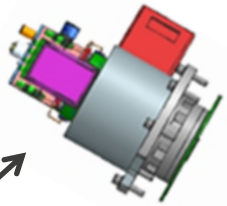
Velocity dispersion between shell inner and outer surface

Brett Scheiner et al. Phys. Plasmas 26 xxxxx (2019)

Dedicate TIM 4 and one backlighter to collect high-resolution x-ray images of our inner Mo shell using the new Fresnel Zone Plate (FZP) imager* to resolve higher mode perturbations on the imploding shell

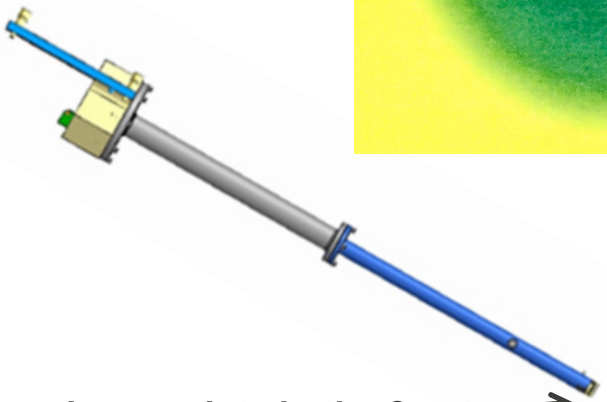
Simulated radiograph of imploding inner Mo shell with 2 um resolution





SCI XRFC detector assembly for data acquisition

TIM 4



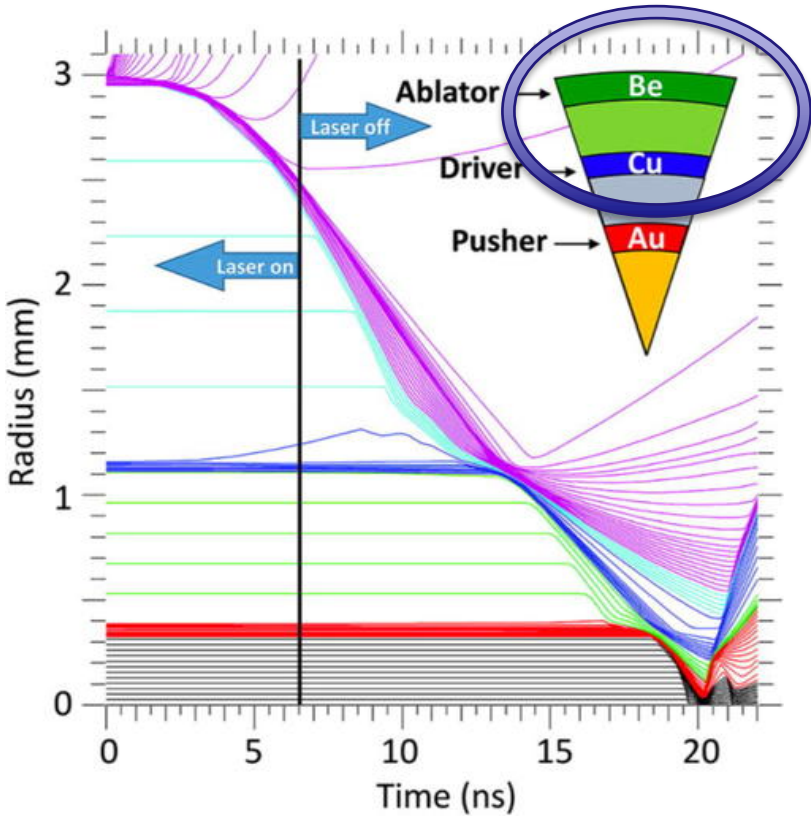
Fresnel zone plate in the front end

FZP design and operation performed by Fred Marshall and Phil Nilson, LLE

Revolver-19B: Validate ablator/driver coupling and develop diagnostics for driver inner shell measurements

- **Motivation**: Revolver 3-shell target can only achieve robust ignition if predicted shell-coupling efficiency is validated. Measuring driver velocity dispersion is an important component of this goal.
- **Goals**: Bound energy transfer to second shell (Mo) using Omega ASBO cone-in platform (39 beams), and backlighting for outer Mo shell implosion trajectory; Continue development of "finger targets" and HSPDV techniques with new mitigation schemes to prevent radiation preheat. Obtain high resolution images of outer Mo surface using Fresnel zone plates to measure mode perturbation across shells.
- **Expt'l PI / Designer**: Scheiner, Wilde, Marshall, Polsin / Schmitt, Scheiner

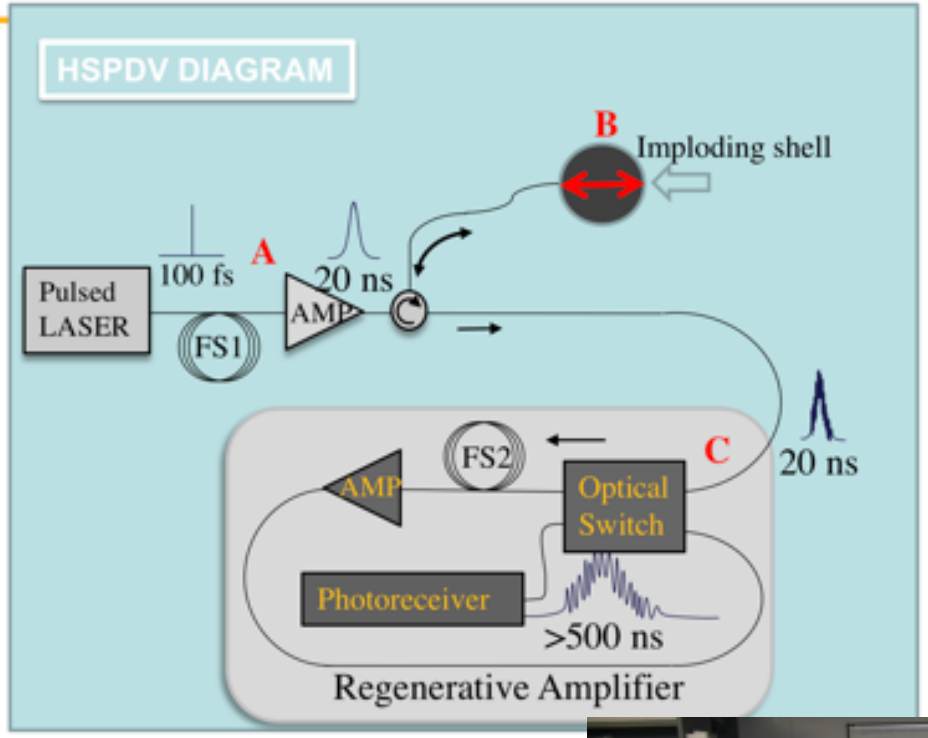
Focusing on outer two shells



Configuration 1: High Speed PDV* via TIM 5 Nova Mount

(A) Stretch fs laser pulse to ~20 ns
(B) Encode PDV signal onto laser pulse (200 km/s → 260 GHz beat frequency, 3.8 ps time resolution)
(C) Stretch signal in dispersive fiber to 260 ns → *beat frequency lowered to 20 GHz*
(D) Record beat frequency on scope and calculate velocity $v = f\lambda/2$ (f = beat frequency)

- Beat frequency occurs from mix between reflections off fiber face and shell
- Initial beat frequency gives distance from fiber to shell with ~1 μm accuracy
- If shell stays reflective, time record of velocity is recorded
- Even if reflectivity goes away, breakout time of shell and impact time on fiber are recorded to give average velocity



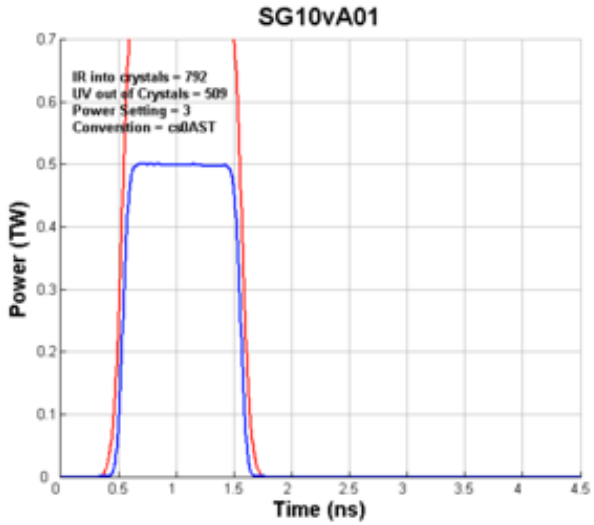
Goal: Measure a continuous time history of the velocity of the inner surface of the inner shell as it implodes at speeds exceeding 100 km/sec

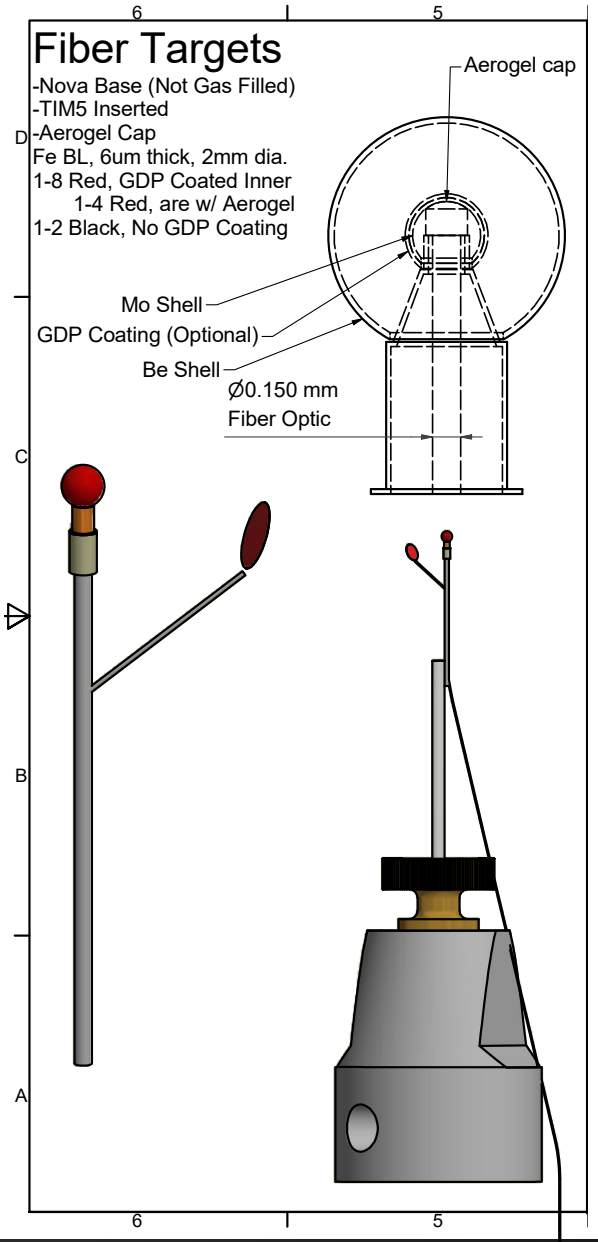
HSPDV data collection performed by Jason Mance, MSTS

Configuration 1: High Speed PDV via TIM 5 Nova Mount

Beams	# CPPs	CPP size	Pulse	Pointing	Energy
39	39	SG5	1-ns square	TCC	225J/Beam
7	0	None	1-ns Square	Fe foil (BL)	450J/Beam
6	0	none	1-ns square	Fe or Ti foil (BL)	450J/Beam

Diagnostic	TIM	Priority
SFC3 (self-emission)	1	1
SFC4 (Backlighter)	2	1
None	3	1
FZP (Backlighter)	4	1
HSPDV/TTP	5	1
Backlighter (TTP)	6	1





Configuration 1: High Speed PDV via TIM 5 Nova Mount

- Two backlighters
  - One on the main target (Fe)
  - One backlighter target (Fe or Ti)
- Requesting maximum energy/beam
- Surface irradiance is ~$8x10^{14}$ W/cm^2
- Pinhole array or FZP

BL Targets

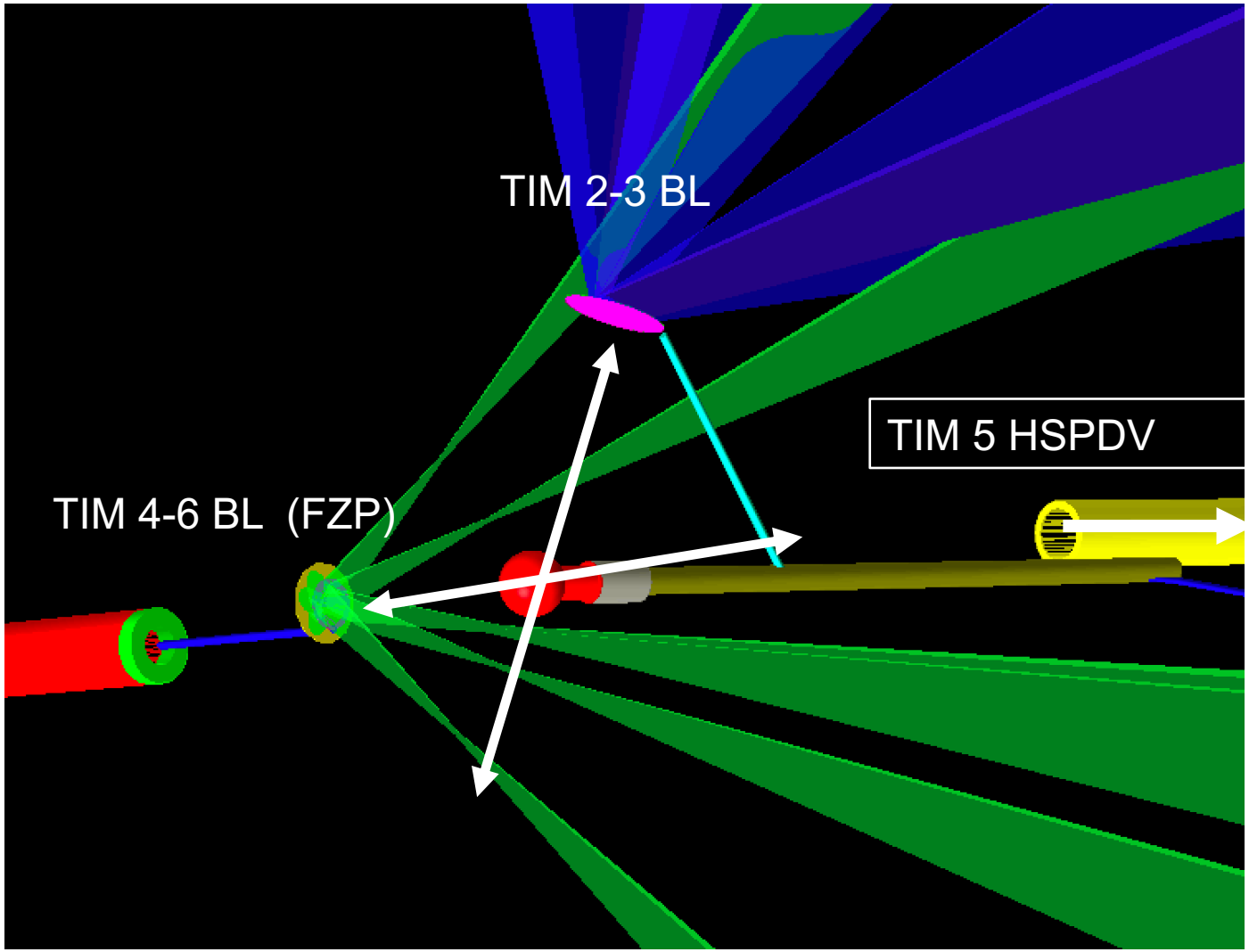
-Fiber Stalk
-TIM6 Inserted
-1.6mm Diameter
1-10 Green (12um thick Fe Bl)
1-10 Orange (12um Thick Titanium)

Backlighter on Main Target

2	15,19,29,38,43,54,64	BL2 Beams	450 J/Beam (UV)	5512 / 142.59 / 344.57	3.9 mm (lens position)	1.3	none	No	TARGET1	C
3	16,21,26,28,33,36	BL1 Beams	450 J/Beam (UV)	5543 / 116.34 / 160.35	-3.7 mm (lens position)	2.5	none	No	TARGET1	B

Backlighter Target

Configuration 1: High Speed PDV via TIM 5 Nova Mount



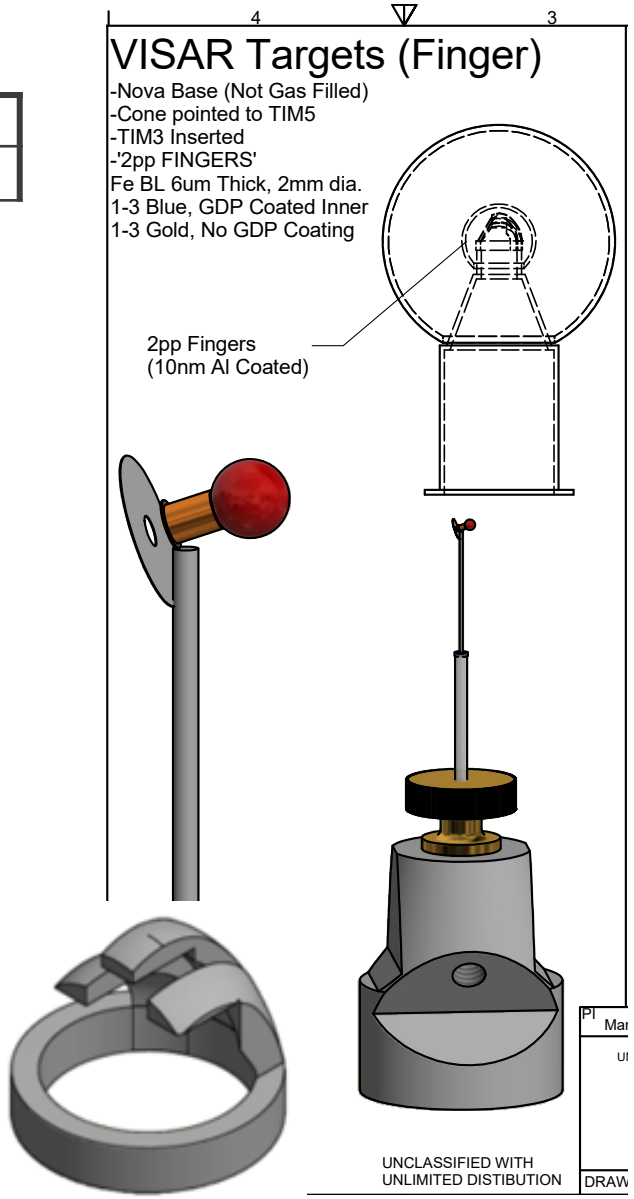
Configuration 2: ASBO with optical “finger” indicators

Beams	# CPPs	CPP size	Pulse	Pointing	Energy
39	39	SG5	1-ns square	TCC	225 J/beam

Diagnostic	TIM	Priority
SFC3 (self-emission)	1	1
None	2	1
Target Positioner	3	1
None	4	1
ASBO Telescope (VISAR/SOP)	5	1
None	6	1

Goal: Measure 3 discrete collision times of the inner shell with the 3 fingers and infer the velocity of the inner surface of the inner shell using these times and the position differences of the fingers.

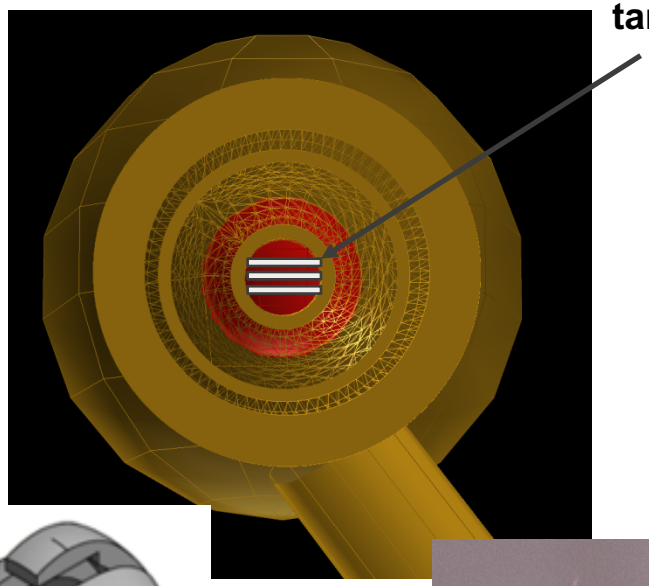
VISAR and SOP data collection supported by Danae Polsin and Tom Boehly, LLE

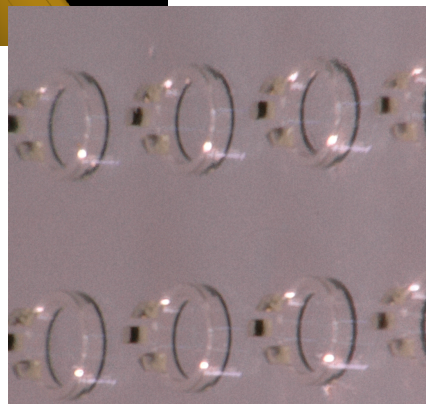


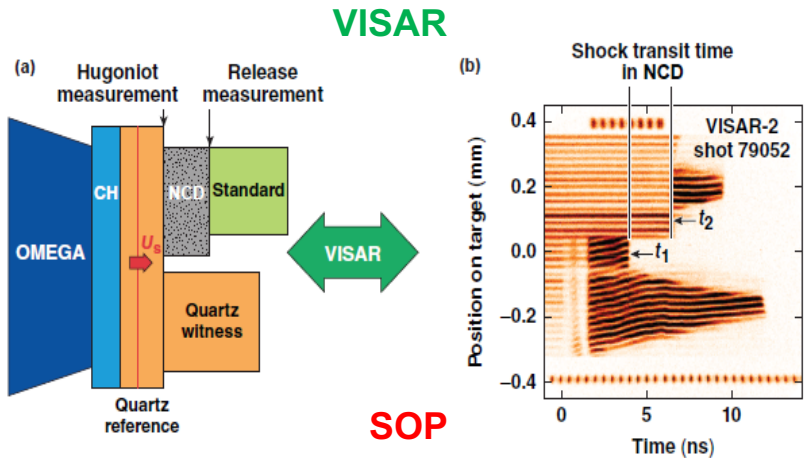
Principles of Finger Target Operation w/ VISAR/SOP

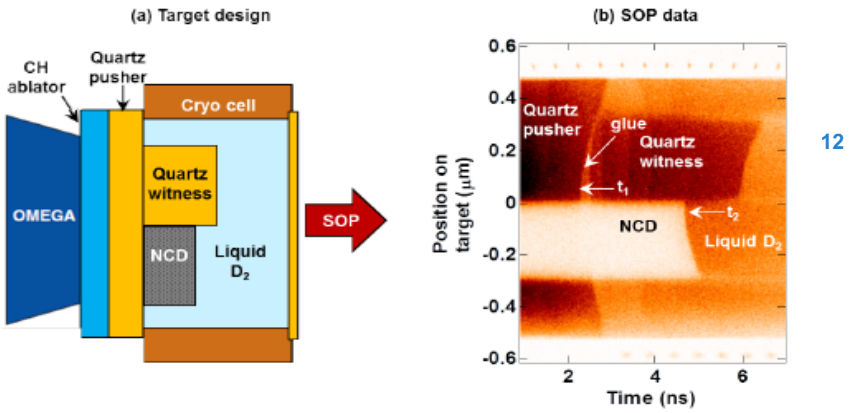
VISAR view H14

Focus on gold ring, then move telescope in known amount from target metrology



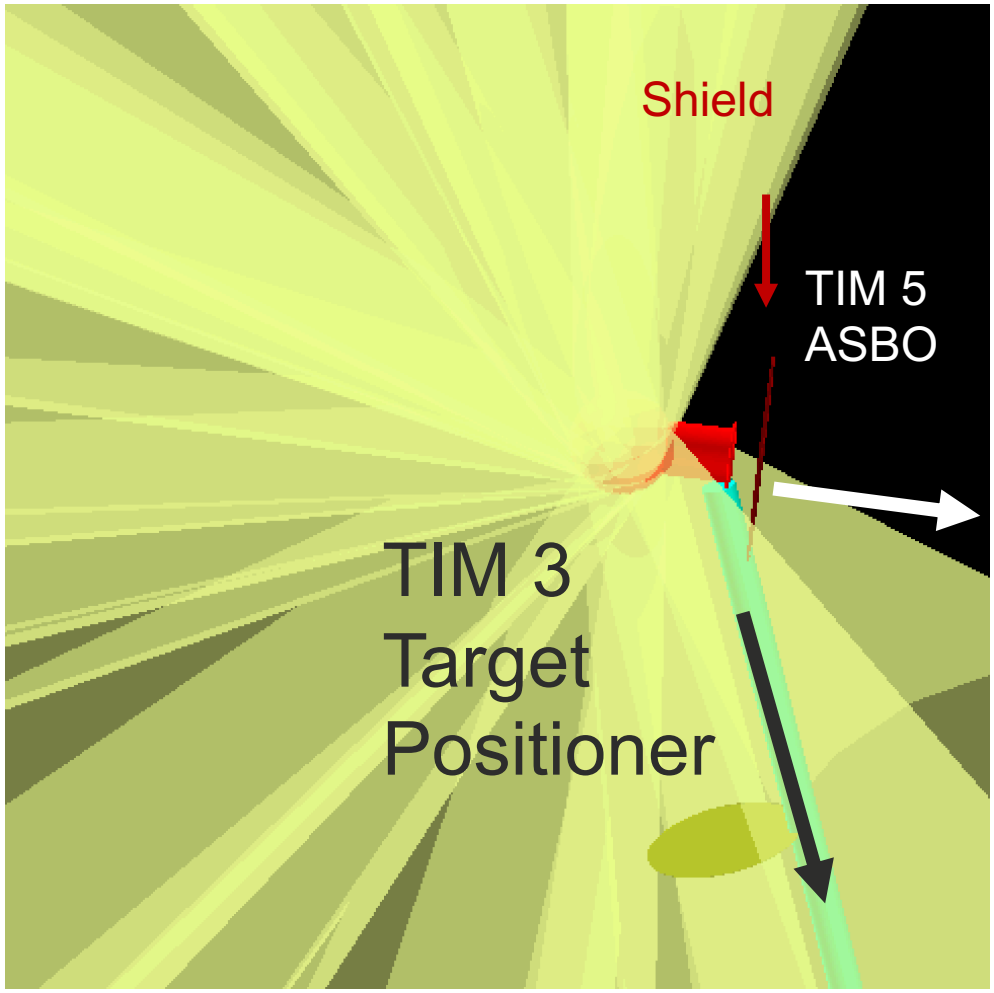






VISAR alignment procedure provided by Danae Polsin (LLE)

Configuration 2: ASBO with optical “finger” indicators



Shot Plan

Shot Order	RID	Type	SFC3 t0 (TIM 1)	SFC4 t0 (TIM 2) BL2	XRFC1 t0 (TIM 4 FZP)	Target	BL Target	Objective
Notes:			Always Self Emission					
1	73739	ASBO	0.4	N/A	N/A	Gold 1	N/A	First finger shot, FZP alignment
2	74642	ASBO	0.6	N/A	N/A	Blue 1	N/A	Second finger shot
3	73700	HSPDV	0	1.5	1.9	Red 5	Orange9	Timing shot for HSPDV, Obtain BL r(t) data,FZP
4	74647	HSPDV	0.2	2.5	2.9	Red 6	Orange10	First data shot for HSPDV, Obtain BL r(t) data,FZP
5	74648	HSPDV	0.8	4	4.4	Red 7	Orange 1	First FZP shot, obtain BL r(t) data, HSPDV
6	74649	HSPDV	0	2	2.4	Red 1	Orange 2	Second FZP shot, HSPDV with Aerogel
7	74650	HSPDV	0.2	3	3.4	Red 8	Orange8	Final shot to obtain r(t) data via BL, HSPDV,FZP
8	74643	ASBO	0.4	N/A	N/A	Blue 2	N/A	Third finger shot, may vary drive
9	74644	ASBO	0.6	N/A	N/A	Blue 3	N/A	fourth finger shot, may vary drive
10	74651	HSPDV	0.8	3	3.4	Red 2	Orange 3	HSPDV with Aerogel, FZP image
11	74652	HSPDV	0	3.4	3.8	Black 1	Orange 4	HSPDV, Uncoated inner shell image with FZP
12	74653	HSPDV	0.2	3.6	4	Black 2	Orange 5	TBD
13	74645	ASBO	0.4	N/A	N/A	Gold 2	N/A	TBD
14	74646	ASBO	0.6	N/A	N/A	Gold 3	N/A	TBD
15	74654	HSPDV	0.8	3.6	4	Red 3	Orange 6	TBD
16	74655	HSPDV	0	3.6	4	Red 4	Orange 7	TBD